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The little book edited by H. O. Ondar contains a collection of letters by A. Markov and A.A. Chuprov exchanged before 1913. In that year the Imperial Academy of Sciences in Moscow celebrated the bicentenary of the law of large numbers symbolized by Ars Conjectandi: the work of Jacob Bernoulli, the Markov/Chuprov correspondence, combined with some other material, provides an interesting perspective on the early history of the modern theory of probability.

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INTRODUCTION TO THE ENGLISH TRANSLATION OF THE MARKOV/CHUPROV CORRESPONDENCE EDITED BY H. O. ONDAR

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It is a great pleasure to write this Introduction, suggested by the translators and requested by Springer-Verlag. What can be more pleasant than to recall one's student days? My own go back to 1912 when, in Kharkov, I often heard Markov being described as "Neistovyi Andrei." This description is difficult to translate. Perhaps "Andrew the irrepressible," with the addition "who does not pull any punches." Two of the characteristic performances of Markov are briefly described by the editor Ondar. One is Markov's fight "against reaction, backwardness and religion." The other is Markov's renunciation of "all honors and decorations he had received from the tsarist government," this in protest against the exclusion from the Academy of A. M. Gorky, the revered writer. Now I wish to add a third item.

In the tsarist regime, membership in the Imperial Academy was occasionally conferred on high noblemen. Neistovyi Andrei did not like this and to manifest his disapproval, composed a limerick. It was about a Duke Dundook becoming a member of the Academy, a limerick not suited for the ears of ladies! It is not likely that Markov's limerick was ever published. It circulated by word of mouth.

The little book edited by Ondar is very attractive. Also, I am highly appreciative of the work of the translators Charles and Margaret Stein. They have retained the somewhat antiquated style of writing of Markov and Chuprov:

long sentences and special forms of civility. Quite apart from the external form, I find the book very interesting, this not only because of the anecdotal aspect of Neistovyi Andrei pulling no punches in his criticism of Chuprov and others. The historical perspective on the happenings documented in the book, compared with the subsequent developments in probability and mathematical statistics is most interesting: certain findings that at the time appeared important did not prove to be significant and vice versa.

In an effort to estimate the culminating point of the Markov/Chuprov dispute, I contemplate the celebration by the Academy of the bicentenary of the law of large numbers, symbolized by Ars Conjectandi, the work of Jacob Bernoulli, published in 1713. In his letter of January 27, 1913 (item 55 of the collection), Markov informs Chuprov that in planning this celebration, he visualizes the possibility of presentations by non-members of the Academy and suggests that he, Chuprov, be one of them. As indicated by the editor Ondar, the response of Chuprov was not found. However, the subsequent letter of Markov (item 56 of the collection) indicates what must have been the contents of the lost letter of Chuprov. In the letter dated January 31 of the same year Markov expresses doubt about the desirability of Chuprov's suggestion to publish a collection of articles by a number of authors, including some from abroad. The reasons for Markov's doubt include the apparent lack of appreciation by the many authors of Bernoulli's work Ars Conjectandi. The proposed speakers at the Academy's celebration are Professors A. V. Vasiliev, Chuprov and Markov. In a letter of March 2 (item 58 of the collection) Markov informs Chuprov of the final approval by the Academy of the above plans and invites Chuprov to his home for a joint discussion with Vasiliev.

Actually, the bicentenary celebration was held on December 1, 1913, as planned. Then, in a letter of December 3 (item 62 of the collection), Markov

informs Chuprov that, contrary to the suggestion of Vasiliev, he is opposed to the joint publication by the Academy of all three presentations, by Vasiliev, by Chuprov and by himself. Because of the lack of mathematical rigor in Vasiliev's and Chuprov's texts, Markov decided to abstain from publishing his own text! The texts of Markov's and Chuprov's bicentenary presentations are available in Ondar's book as Appendices 3 and 4, respectively.

Now, a few remarks on historical perspectives.

(i) In his many writings Markov emphasized his mathematical rigor. While the text of his presentation at the Academy's bicentenary celebration is focused on Ars Conjectandi, the successive editions of Markov's book Calculus of Probability are aimed at the building of the general theory. The Introduction of the third edition, published in 1913 and marked 'Two Hundred Year Jubilee of the Law of Large Numbers," is specific in mentioning ". . . foundations of the calculus of probability . . ." In due course the success of Markov's efforts in this direction became subject to doubt that stimulated other scholars to do better. Without much risk of oversimplification, one might say that modern mathematical theory of probability was born two decades later, due to the work of Academician Andrei Nikolaievich Kolmogorov. Kolmogorov's most inspiring study has the title Grundbegriffe der Wahrscheinlichkeitsrechnung. It was published in 1933 by Julius Springer.

Outstanding contributions during the period 1913-1933 may be exemplified as follows: (1) Generalization of the central limit theorem by S. N. Bernstein, my teacher of probability; (2) Harald Cramér's study of 1928; (3) George Pólya's papers on random walk (1919) and on contagion (1930); (4) Émile Borel's Le Hasard (1914); (5) Borel-Cantelli lemma (before 1928); (6) Paul Lévy's characteristic functions and his book of 1925; and (7) Richard von Mises' Theory (1931).

(ii) By the end of his bicentenary speech (Appendix 3 of the Ondar book) Markov refers to the "developments of the law of large numbers that belong already to our time" and mentions "the broadening of the field, in particular, to the extension to DEPENDENT TRIALS and DEPENDENT RANDOM VARIABLES . . ." (Caps are mine.)

Here, the capitalized terms refer to Markov chains. As is well known, Markov chains generated the theory of Markov processes and, more generally, the theory of stochastic processes that now preoccupies many thousands of scholars all over the world. What a difference from Markov's own opinion about just a broadening of the field of the law of large numbers!

(iii) Preoccupied with the law of large numbers, Markov and (to a degree) Chuprov fail to take notice of a novel subject of study. This subject may be symbolized by the title of a paper by G. T. Fechner Kollektivmasslehre published in 1897. The term Kollektivmasslehre may be translated as the study of properties of "collectives," now called "populations." These collectives are supposed to be composed of many entities, all satisfying a certain definition, but differing from each other by some individual characteristics.

The consciousness of populations as an important subject of study is reflected in the famous work of Laplace Théorie Analytique des Probabilités. Here, in the edition of 1820, pp. 261-263, Laplace considers two populations of "astronomical entities." One is the population of planets in the solar system. The other is the population of comets. Laplace was interested in the question whether the comets are members of the solar system just like planets, or intruders from the outer space.

When the concept of the Kollektivmasslehre became broadly familiar, there resulted several efforts to develop methodology capable of characterizing the distribution of individual characteristics of population members. The most

successful methodology seems to be that of Karl Pearson, commonly known as "Pearson curves." These curves have been sharply criticized by Markov on account of being interpolatory devices, not resulting from a limit theorem on probabilities. This interpolatory character notwithstanding, Pearson curves are useful in many empirical studies.

The attitudes of Markov and Chuprov towards population studies, as reflected in their presentations at the Academy meeting of December 1, 1913, are not identical.

A number of passages in Chuprov's presentation indicate his awareness of populations as important subjects of study. In the very first paragraph of Chuprov's text (Appendix 4) we read: ". . . interest in collective phenomena." One of subsequent pages contains an even more relevant passage. Here, Chuprov writes about efforts of statisticians to base their studies on complete coverage of a population that is very large. He writes: 'However, even when a complete count is not impossible, statisticians are beginning more and more to revert to sampling studies, because of the saving of labor and expense."

Here, I wish to document an achievement of Chuprov not mentioned in Ondar's book. The following passage is reproduced without change from the Journal of the Royal Stat. Soc., Vol. CXV (1952), p. 602.

> Recognition of priority.-- Professor J. Neyman of the University of California writes: I am obliged to Dr. Donovan J. Thompson of the Statistical Laboratory, Iowa State College, Ames, Iowa, for calling my attention to the article of A. A. Tschuprow, "On the mathematical expectation of the moments of frequency distributions in the case of correlated observations" published in Metron, Vol. 2, No. 4 (1923), pp. 646-683, which contains some results refound by me and published, without reference to Tschuprow, in 1933.
>
> The results in question are the general formula for the variance of the estimate of a mean in stratified sampling and the formula determining the optimum stratification of the sample. These formulae appeared first in a Polish booklet An Outline of the Theory and Practice of Representative Method, Applied in Social Research published in 1933 by the Warsaw Institute of Social Problems. Later on they

were republished in English in the Journal of the Royal Statistical Society, Vol. 97 (1934), pp. 558-625. Finally, the same formulae, again without a reference to Professor Tschuprow, were given in the second edition of my book, Lectures and Conferences on Mathematical Statistics and Probability, Washington, D.C., 1952.

The purpose of this note is, then, to recognize the priority of Professor Tschuprow, to express my regret for overlooking his results and to thank Dr. Thompson for calling my attention to the oversight.

P.S. Some readers of the English translation of Ondar's book may find it convenient to be reminded that the following four names refer to the same city: St. Petersburg, Petersburg, Petrograd and Leningrad. The city's original name, St. Petersburg, was changed to the Russian name, Petrograd, in 1914. After the death of Lenin in 1924 the city was renamed Leningrad.

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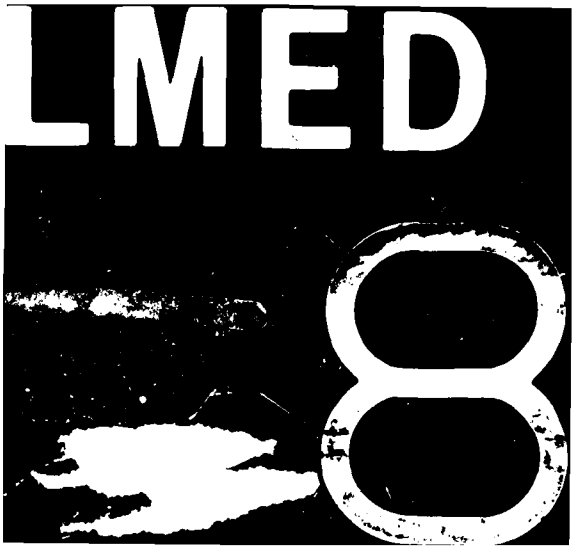
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